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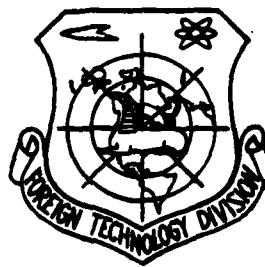
FOREIGN TECHNOLOGY DIVISION



COMPUTERS AND THE CONTROL OF THE TRANSPORTATION PROCESS

by

P. F. Krivonos



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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А	А <i>а</i>	А, a	Р	Р <i>р</i>	Р, r
Б	Б <i>б</i>	Б, b	С	С <i>с</i>	С, s
В	В <i>в</i>	В, v	Т	Т <i>т</i>	Т, t
Г	Г <i>г</i>	Г, g	Ү	Ү <i>ү</i>	Ү, ү
Д	Д <i>д</i>	Д, d	Ф	Ф <i>ф</i>	Ф, f
Е	Е <i>е</i>	Е, ye; Е, e*	Х	Х <i>х</i>	Хх, eh
Ж	Ж <i>ж</i>	Zh, zh	Ц	Ц <i>ц</i>	Ts, ts
З	З <i>з</i>	Z, z	Ч	Ч <i>ч</i>	Ch, ch
И	И <i>и</i>	I, i	Ш	Ш <i>ш</i>	Sh, sh
Я	Я <i>я</i>	Y, y	Ц	Ц <i>ц</i>	Shch, schen
К	К <i>к</i>	K, k	Ь	Ь <i>ь</i>	"
Л	Л <i>л</i>	L, l	Ҥ	Ҥ <i>ҥ</i>	Y, y
М	М <i>м</i>	M, m	Ҥ	Ҥ <i>ҥ</i>	"
Н	Н <i>н</i>	N, n	Э	Э <i>э</i>	E, e
О	О <i>о</i>	O, o	Ҥ	Ҥ <i>ҥ</i>	Yu, yu
П	П <i>п</i>	P, p	Я	Я <i>я</i>	Ya, ya

*ye initially, after vowels, and after ь, ы; е elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	sinh ⁻¹
cos	cos	ch	cosh	arc ch	cosh ⁻¹
тg	tan	th	tanh	arc th	tanh ⁻¹
cтg	cot	cth	coth	arc cth	cotanh ⁻¹
sec	sec	sch	sech	arc sch	sech ⁻¹
cosec	csc	csch	csch	arc csch	csch ⁻¹

Russian	English
rot	curl
lg	log

COMPUTERS AND THE CONTROL OF THE TRANSPORTATION PROCESS

P. F. Krivonos, chief of the Southwestern Road

Under contemporary conditions of scientific-technical progress the control of production is becoming more and more complex and requires the continuous processing of a large volume of information, intensification of the role of economic levers, and employment of economic-mathematical methods. A further rise in the quality of control is possible based on the use of electronic computers (EVM).

On the Southwestern Road, computers are now employed in operational planning of operation work, the development of monthly shipment plans, the organization of accounting for the work of the road, the calculation of schemes for normal directions of freight flows, and the solution of a number of tasks.

The road's computer center (VTs) is connected by channels of two-way information communications with the stations originating the train flows, with the junction points of the Southwestern and adjacent roads, road management services, and sections and the Computer Center of the MPS [Ministry of Railways]. Flows of information and the corresponding results of calculations are transmitted in the form of set-ups over these channels between subdivisions of the road and the VTs. The structural scheme for the transmission of information which is necessary to control the

transportation process using computers is constructed in accordance with the operating system for controlling the work of the road as a whole.

INFORMATION-PLANNING SYSTEM

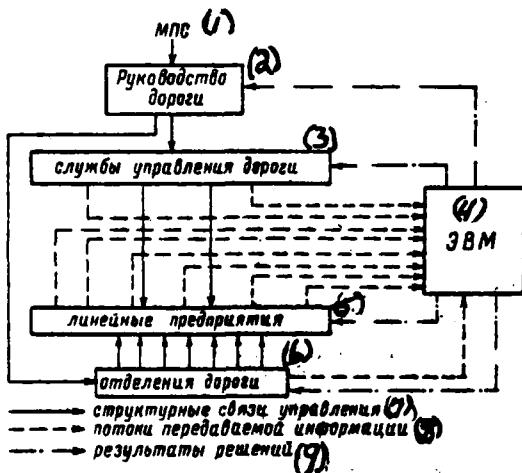
The first stage of the ASUZhT [Automatic Railway Control System] - the information-planning system (IPS) - is being developed and introduced on the Southwestern Road. Along with the computer equipment it includes technology for the collection and transmission of information, technical devices for data transmission, and software for the solution of problems.

The information-planning system is based on train and freight information: a full-scale train sheet, information on loading and unloading, on the operation of locomotives, on the passage of the trains through the junction points, data on the situation at the shunting stations by the start of the planning period, and so forth.

The structure for the information service has been developed on the road. Special information groups have been created in the road's administration and in the divisions, information centers at the shunting stations, information offices on the sections and big freight stations, and information points at the base stations.

The information group for management of the road (IGu) accomplishes the monitoring and overall direction of information transmission on the road and works out and directs the introduction of methodological instruction on organizing train and freight information at the stations and in the road divisions. The deputy chief of the operations-management section of the traffic service for information heads the information group in the road administration.

Along with the overall direction of the organization of information at the stations, the information groups of the road divisions (IGo) accomplish the transmission of information on the approach of freight. The deputy chiefs of the traffic departments or else the deputy senior dispatchers head the information groups in the divisions depending on the volumes and importance of the information flows. The greatest volumes of information arrive at the information centers of the humping stations (ITs) since here all information on the approach of trains, locomotives, and other data necessary for the planning of train-formation and calculations of a number of other problems on the computer are concentrated here.



Structural diagram of the transmission of information on the Southwestern Road.

KEY. (1) Ministry of railways, (2) Road management, (3) Road control service, (4) Computer, (5) Line enterprises, (6) Road divisions, (7) Structural communications of the administration; (8) Flows of transmitted information; (9) Results of solutions.

The information offices (IB) on sector and freight stations transmit both train as well as freight information while the information points (IP) at the base stations only transmit information to the consignees concerning the approach of freight. This structure of the information service on the road recently permitted a considerable improvement in the quality of information concerning the approach of trains and freight and an increase in its reliability as well as a reduction in the transmission times.

The technology for organizing information flows in the IPS system envisages the transmission of train information from the stations of train-flow origination of the Southwestern as well as adjacent roads from set-ups of established form (a telegram showing the composition and freight schedule) directly to the VTs and simultaneously, to the train's station of destination. Interroad and interdivision junction points should transmit to the VTs only information on the passage or arrival of trains. All this permits keeping track of fleets of railroad cars and locomotives by divisions and road and also the railroad-car flows by departure points and destination roads. Information on loading and unloading is transmitted from the divisions of the road (and subsequently, with sufficiently developed information communications, also from the stations) to the VTs, and from the depot - concerning the readiness of the locomotives for dispatch for a train.

The use of computers in the operational planning of work required an improvement in information communications. In 1968, the engineering-technical personnel of the computer center, signalling and communication service, and the Planning-Research Institute of the Southwestern Road (Zheldorfproyekt) developed a plan for the development of the road's information communications. All work in accordance with this plan with a cost of 500,000 rubles was accomplished using non-centralized sources of financing by the efforts of the signalling and communications districts. Information communications with the stations of distant points from the Moscow, Southern, and Odessa-Kishinev Roads was organized using the road's resources. To introduce the IPS, it became necessary to accomplish the further development of information communications. A plan was similarly worked out in 1970 and work costing more than one million rubles is now being accomplished.

Thus, the measures conducted by the road to increase and develop information communications on the first stage will provide for the transmission of the necessary volumes of information in the IPS system.

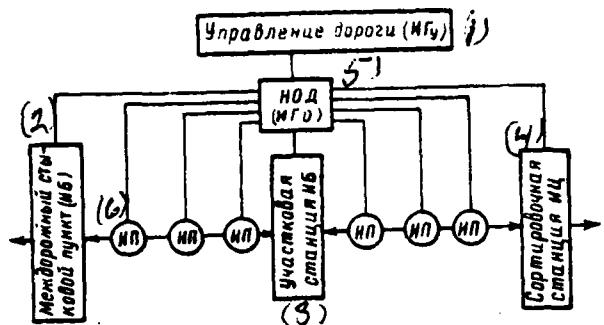


Diagram of information service.

KEY: (1) Road administration (MGU);
 (2) Interroad junction point (IB);
 (3) Section station of IB, (4)
 Humping station of ITs, (5) NOD
 [chief of traffic department] (IGO),
 (6) IP.

As is known, an important role for the reliable and quality operation of an automated control system and for the solution of any problems on computers is played by the software. For the IPS, the software is a complex of computer programs. A portion of the programs provides for the input, editing, and processing of all information which arrives in accordance with print-out set-ups for the creation of a data bank in the computer. Other programs prepare files for the solution of specific problems and control the calculation process in real time. A number of additional programs have been developed such as, for example, a program for changing the marshalling plan at the humping stations, changing the schedules for train traffic, technological standards, and so forth.

The most important of the programs listed are the special software programs. They include the programs for the current planning of the work of the Darnitsa, Zhmerinka, Shepetovka, Konotop, and Korosten' humping stations for four hour periods and the programs for the daily-shift planning of the divisions' work and that of the road as a whole which provide for the planning of the reception and dispatch of trains and railroad cars by junctions, loading, unloading, adjustment of assignments, providing the trains with locomotives and, when necessary, the accomplishment of operational tasks. The programs for daily shift planning of work are intended for calculations in accordance with six-hour periods of the day.

The processing of the indicated information will permit introducing automated operational accounting and record keeping on the road without receiving additional information from the stations and divisions. This includes, first of all, the accounting for fleets of railroad cars by types of rolling stock as well as loaded and empty freight cars, accounting for freight-car flows by departures and roads of destination to include the local loading for divisions and the road, and accounting for and disposition of the locomotive fleets. On this basis, the VTs should put out reports for divisions, roads, and the MPS and should analyze the work of the road and the divisions for the period of the day which has elapsed. During calculations using the computer, plans are drawn up in the VTs for the reception of trains and railroad cars by junctions of the road and divisions with the singling out of the local cargo as is a plan for unloading by divisions and the road as a whole as well as by types of rolling stock for the forthcoming day and the first half of the day. Work is conducted on introducing machine planning of the loading and turn-over of the loaded freight cars and regulating empty freight cars as well as train locomotives. All calculations will be based on the use of information flows which are called for in the IPS. This will permit a considerable increase in the quality of use of the rolling stock. When the road dispatchers have accurate data available concerning the location of freight cars, trains, and locomotives on the road it will provide the opportunity to organize the transportation process more efficiently. The creation of the IPS will also permit the working out of technical standards for the operational work of the road using the computer.

The computer center which has been created on the road is equipped with two "Minsk-22" computers which have proven to be good in the solution of problems which are small in volume. To increase the functional reliability of the IPS, personnel of the VTs together with the Institute of Cybernetics of the Academy of Sciences of the Ukrainian SSR organized the combination of two computers into a single computer complex on the network of roads

for the first time. Both computers are controlled from either of two consoles, in which regard their auxiliary storage and immediate access storage are used as a single storage while the input of information over the channels will be accomplished directly into the computer, permitting a reduction in the volume of auxiliary storage by half for the storage of the same programs and information, providing flexibility in the selection of storage for the solution of specific problems, and increasing the operating reliability of the computer complex as a whole since with a failure in the operation of the devices of one machine the solution of the problem is automatically transferred to the similar devices of the other computer. Thanks to the direct input of information into the computers, bypassing the information center, the accelerated check and correction of information which arrives is ensured.

Thus, the information-planning system as the totality of organizational, technical, and mathematical methods of computer technology and means of communication which reflects the status of trains on the road in good time will permit controlling the transportation process with higher quality. The computer equipment will accomplish the basic labor-intensive work in processing large information flows and selecting the optimum control modes.

PLANNING THE WORK

On the road, the computer is used to plan train formation for the basic humping stations. Here, the following tasks are accomplished: working out plans for the arrival of trains at the station for four-hour periods, plans for the breakup of the trains, determining the readiness times of the rolling stock for its marshalling and of through trains for departure from the station. Furthermore, plans for the sorting of small consignments, the delivery of local freight, and providing the trains with locomotives are calculated at Darnitsa Station.

Information for planning train formation of the humping stations goes to the VTs of the road in the form of telegrams of schedules showing the composition and freight details of trains continuously as trains are dispatched from the stations of origin of the car flows of the Southwestern road as well as from distant stations of adjacent roads. The information which arrives is processed in the computer. As a result of the processing, information is grouped for each train in accordance with the conventional length and weight for each destination in the marshalling plan. All information is accumulated in this form on magnetic tapes where all standard-reference information which is subsequently used in calculations is also stored in coded form.

Immediately prior to the start of a new planning period, information on the availability of trains in the receiving yards, on trains which are ready for dispatch in the departure yards, and data on the accumulation of railroad cars on the tracks of the humping yards is transmitted to the VTs from the stations for which plans must be calculated. In the divisions of the road, the exchange of information is accomplished for four-hour periods between dispatchers concerning the transfer of trains by junction points with the indication of their destination and possible time of arrival at the break-up station. This information goes to the VTs where the automated selection of information from magnetic tapes is accomplished and the calculation of the plan is performed. Here, the criterion of the plan's optimum nature is ensuring the minimum number idling car-hours.



Computer room of computer center.



Inspection of the computer peripheral gear.

As a result of the calculations, plans for the arrival of trains for the new period are transmitted from the computer center to the junction dispatchers of divisions and the duty officer for the operational - administrative department of the road's traffic administration service over telegraph communication channels for the humping stations. These plans include data on the availability of cars in trains in accordance with the plan's designations for humping with an indication of the optimum sequence for break-up and humping and plans for the dispatch of trains with consideration of the rolling stock's readiness, the availability of locomotives, and the lines of the schedule. The shunting dispatchers of the stations organize shunting work in accordance with these plans. With deviations in the sizes of the car flows from those forecast, current adjustment of the train-formation plans is accomplished in the road's VTs and the corrected data are transmitted to the humping stations.

As a result of the introduction of computerized planning for train formation at the road's humping stations, a large number of workers were freed from unproductive labor in the manual processing of information and the quality in preparation of daily-shift plans for the operation of the stations was improved considerably. Here, during the last two years the time that a through-train was at the Darnitsa station of the road with remarshalling was reduced by almost one hour.

Along with the planning of train formation using computers, the mechanization of operational-statistical accounting and record keeping has been accomplished on the Southwestern Road. Here, a large flow of train and freight information from the divisions and from the road's junction points is input into the computer memory, in which regard all data which have been coded only once are used not only for planning the work but also for preparing operational reports on the operation of the road.

Now, computers are used to process operational data on loading for roads of destination and type of rolling stock (form GO-3), on the presence of loaded cars by roads of destination (form DO-39) and the exchange of trains and cars by junction points (form DO-1), information on car flows by junction points (form DO-15), data on loading by types of rolling stock (form GO-1) and on the loading by type (form GO-2), as well as other types of reporting documents. In connection with the fact that all information for the processing of these accounting forms goes to the road's VTs over telegraph channels of communication directly from the stations and divisions, its quality is increased significantly.



An operator debugs a new routine on a computer.

On the basis of the reporting documents which are processed using a computer, reports on the operational work by basic volume

and quality indices are prepared daily in the road's VTs: loading, unloading, car fleets, car circulation, quality of schedule preparation for the train traffic, productivity of cars and locomotives, releasing of cars, ton-kilometer work, and so forth. These data are sent to the divisions, the administration service of the road, and to the MPS.

It should be noted that computer processing of information permitted a sharp reduction in the flow of reporting documents and telegrams. The availability of data which have been obtained and generalized in good time permits each supervisor to analyze the work of the corresponding subdivisions more quickly and easily and to adopt necessary measures to eliminate various "bottlenecks" in the production process.

The employment of computers provides a great impact when calculating monthly plans of shipments and normal freight-flow schemes. These calculations are accomplished in the following manner. The road's freight service sends requests for loading which have been received from the freight dispatchers directly to the computer center. As a result of the computer processing of information, a loading plan for the month as a whole for the road as well as by divisions, stations, and freight shippers is prepared.

Here, in the course of calculations on the computer inefficient shipments, nonconformance of the type of load to the type of rolling stock, and underutilization of carrying capacity of the cars on the strength of the technical norms for loading by each type of load are disclosed. Inefficient shipments are established in the course of solving the transportation problem of linear programming and on the basis of the loads of the loading and unloading points proposed by the shippers by specific types of loads. Nonconformance of the type of load to the type of rolling stock requested is established by programmed logic monitoring in the computer while underutilization of the carrying capacity of cars is determined by calculating the mean static load by types of cargoes and the

comparison of the results obtained with technical norms in the computer memory.

Thus, all laborious work on preparing monthly shipment plans on the Southwestern Road is completely automated. Simultaneously with the calculation of the monthly loading plan, a loading plan is prepared by types of rolling stock, types of freight, and roads of destination.

An entire series of analytical and engineering problems is solved using computer technology on the road. Thus, formerly personnel of the track districts and planning organizations spent much time on calculating the displacements of the multi-degree curves of railroad track. Now, these calculations are accomplished on a computer in 10-15 minutes. At the present time, the computer is also used to perform calculations with the shippers and recipients of cargoes in the Kiev junction calculation commodity office (URTK). Along with this, problems which formerly were impossible to solve manually such as, for example, the calculation of the asymmetry of currents and voltages in the road's power-supply network are also solved.

PROSPECTS FOR AUTOMATION

In accordance with the integrated plan for the acceleration of technical progress and increase in the effectiveness of rolling-stock utilization which has been worked out on the road, as well as with the growth in the productivity of labor in the current year, calculations of the optimum name schedules for the operation of the locomotive brigades for passenger traffic will begin to be worked out in the Kiev-Passazhirskiy [Kiev Passenger] locomotive depot. The basis for the calculation of these schedules will be the operating traffic schedule of trains which are being serviced by the Kiev-Passazhirskiy locomotive depot.

Lists of the circulation of locomotive brigade in accordance with the engine distances and with consideration of the norms for rest and monthly wages and, on their bases, the name schedules for the operation of the locomotive brigades with indication of the numbers of the trains and the days for departure on a trip and return to the depot will be prepared on the computer. This will ensure a uniform loading of all locomotive brigades by days of the month, the clear observance of the established duration of continuous work and rest, and the timely granting of days off to the workers. Along with this, the established monthly norm of output will be established for each engineer and assistant.

The integrated processing of the engineer's route on the computer will permit refraining from preliminary calculations in the depot and at the factories having mechanized accounting. Operational accounting will be prepared in the VTs of the road on the basis of the processing of this information, the consumption of fuel and electric power will be considered, and the wages will be calculated for the basic categories of personnel.

Along with these tasks, the integrated processing of the freight bill will be accomplished in the road's VTs and this will permit the automation of the calculation of road incomes for the shipment of freight, mutual calculations between shippers and receivers of the freight and the road, and the preparation of freight accounts.

An automated system for material-technical supply which will provide for the solution of bookkeeping and operational tasks is being worked out on the road. The bookkeeping tasks include calculations with suppliers and consumers, the arrival of material valuables from suppliers by types of operations and balance accounts, the release and sale of material valuables for the road's main materials warehouse, and classified accounting and movement of material valuables through the warehouse and the storeroom. In the course of solving operational tasks, the accounting for the

accomplishment of deliveries in accordance with contracts and orders will be accomplished, the deviations of actual reserves from the established norms will be determined, materials in especially short supply and spare parts and the accomplishment of supply plans will be considered, and the allocation of materials and spare parts which arrive at the main materials warehouse for the road's consumers on the supply plan's account is accomplished.

The introduction of this system in the Southwestern Road will begin this year. The organization of automated accounting for material-technical supply will permit a clear monitoring of the movement of material valuables, the timely reaction to surpluses and shortages of articles and spare parts, and the accelerated rate of turnover of working capital.

The introduction of the information-planning system and the accomplishment of the integrated processing of the schedule which shows the composition and freight details of the train, the engineer's route, and the freight bill will also permit accumulating in the computer memory all data which are necessary for planning the repair of the tracks depending on the freight traffic and the repair of the rolling stock in accordance with the periods for inter-repair mileage.



Teletype operator codes information onto punched tape.

Along with the solution of problems in the control of freight shipments using a computer, the ASUZhT also presumes an automated system for the control of passenger shipments. The introduction of an automated system for ticket and cashier operations on the Kiev direction of the Southwestern Road will have great significance. In this regard, this system will be tied in with the "Ekspress" [Express] system which is being introduced on this direction of the Moscow Road.

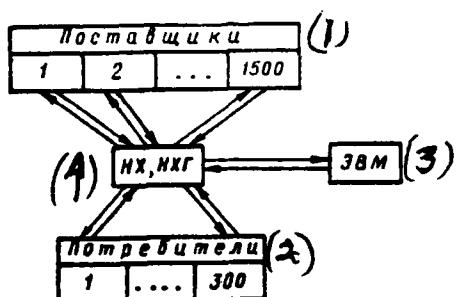


Diagram of an automated system for material-technical supply.

KEY: (1) Suppliers; (2) Consumers; (3) Computer; (4) NKh, NKhG [expansions cannot be determined from text].

As a result of its considerable complexity, the conduct of this work will require a further increase in the means for computer technology. Even in this current year the computer center of the Southwestern Road will be equipped with the "Minsk-32" electronic computer. Here, the available computer complex based on the "Minsk-22" computers will be used primarily for the reception and processing of information while the "Minsk-32" computer will be used for calculating problems on the basis of the information which is received. The construction of a new building for the computer center with organizational communications and a complete complex of computers will begin in 1973. Subsequently, the expansion of the range of problems to be solved will require additional computer capacities.

Problems in the type classification of computers for roads of the network should be finally solved in the future since the presence of computers of various types creates difficulties in the

coordination of the VTs's of different roads during the transmission and processing of information. It is also necessary to speed up the development of a single system for coding information and co-ordinating the work of the computer centers in working out problems in accordance with common procedures.

The reliable functioning of the ASUZhT which is being created on the Southwestern Road will require the corresponding training of a broad range of personnel to accomplish both the transmission of the necessary information as well as the control of the transportation process. Now, permanently operating courses on the training of teletype technicians where more than 100 people are being trained have been organized with the Kiev Electromechanical Technical School. In the training institutes of the MPS, a large number of supervisors of the road's administration services, divisions, and line enterprises as well as a broad range of technical-engineering personnel are undergoing retraining on the basis of a profound study of computer technology. The personnel of the computer center and corresponding services constantly go out on the line and conduct consultations for the shunting dispatchers of stations, station duty officers, acceptance and transfer officers for cargoes and baggage, and other personnel who are directly occupied with train and freight work. The training of qualified personnel to service the automated system for controlling the operation of the road will make it possible to utilize the computer equipment more effectively.

The use of computer equipment will provide a great economic and social impact, will free a broad range of personnel from unproductive manual processing of information, and will permit them to accomplish the control of the transportation process more profoundly and more thoughtfully.